

**BY ORDER OF THE
SECRETARY OF THE AIR FORCE**

AIR FORCE INSTRUCTION 21-124

8 DECEMBER 2010

Maintenance

OIL ANALYSIS PROGRAM



COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

ACCESSIBILITY: This publication is available digitally on the AFDPO WWW site at:
<http://www.e-publishing.af.mil>.

RELEASABILITY: There are no releasability restrictions on this publication.

OPR: AF/A4LM

Supersedes: AFI21-124, 4 April 2003

Certified by: AF/A4L
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Pages: 12

This instruction implements AFD 21-1, *Air and Space Maintenance*, and Joint Publication AR 700-132/ OPNAVINST 4731.1C/AFI(I) 21-131, *Joint Oil Analysis Program*. It provides procedural guidance and assigns responsibility for managing the Air Force Oil Analysis Program and for participating in the Joint Oil Analysis Program. It applies to all military and civilian AF personnel including Major Commands, Direct Reporting Units, Field Operating Agencies, and DoD contractor activities. It also applies to the Air Force Reserve Command (AFRC) and the Air National Guard (ANG). For the purposes of policy the Air National Guard (ANG) is recognized as a MAJCOM. AF/A4L must approve any deviations from this instruction. Refer recommended changes and questions about this publication to AF/A4LM using AF Form 847, *Recommendation for Change of Publication*; route AF Form 847 from the field through MAJCOM publications/forms managers. Records Disposition. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with AFMAN 33-363, Management of Records, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at <https://www.my.af.mil/afirms/afirms/afirms/rims.cfm>. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

SUMMARY OF CHANGES

This instruction has been substantially revised and must be completely reviewed. Major changes include; terminology of current technologies, designation of current organizations and removal of reference to a deleted AF Form. The *Glossary of References and Supporting Information* (**Attachment 1**) has been revised to include references, acronyms and key terms.

1. Program. Oil Analysis is a part of the engine health management plus concept. It is the process of analyzing oil and other fluids used to lubricate or operate mechanical equipment, evaluating the condition of the fluid or the equipment from which the fluid originated, and recommending maintenance actions to the equipment operating activity. An Oil Analysis Program (OAP) ensures timely and accurate oil analysis support through the strategic location of oil analysis laboratories and the standardization of procedures, data elements, analytical instrumentation and diagnostic techniques. The Joint Oil Analysis Program (JOAP) is a combined effort of the Army, Navy and Air Force to set-up and maintain a standard program. Oil analysis requires a centrally-managed program and the integration of AF OAP and JOAP plans.

2. Objectives. The overall objective of the AF OAP is to detect oil-wetted air and space equipment failures before serious malfunction or secondary damage occurs. The specific objectives of the AF OAP and JOAP programs are as follows:

2.1. Improve the operational safety, readiness and economy of military equipment through the use of on-board and off-board oil analysis, a condition-monitoring concept that relies on the detection and measurement of wear-metals in the fluid.

2.2. Collect and analyze oil analysis data in order to increase the effectiveness of oil analysis techniques in the diagnosis of potential equipment failures and lubricant condition; to provide wear metal and lubricant physical property data to the various weapons system managers and others, as required.

2.3. Ensure oil analysis plans and operations are integrated (where practical) to provide:

2.3.1. Standard laboratory techniques, procedures, data, calibration standards, and analytical instruments.

2.3.2. Inter-service oil analysis support to all military departments.

2.3.3. The most cost-effective means of determining the condition of lubricants, fluids, and mechanical system through the use of various analytical techniques.

3. Guidance. The OAP helps aircraft technicians and supervisors to make informed, condition-based, preventive maintenance decisions, and can reduce equipment costs, increase equipment availability, and reduce in-flight risk. This is primarily achieved by monitoring the concentration of wear metals in fluids used to lubricate or power mechanical systems. To monitor engine health, the OAP uses a variety of testing mechanisms. These include: atomic emission (AE) spectrometric wear metal analysis, filter debris analysis (FDA), magnetic chip detectors (MCD), MCDs with on-board sensors, Scanning Electron Microscope/Energy Dispersive X-ray (SEM/EDX) system technology (e.g., JetSCAN®), and to a very limited extent, physical property testing (viscosity, water/fuel contamination, additive levels, etc.). To the extent deemed cost effective, Engine Operating Time (EOT) should be used as the standard time interval between oil analysis sampling when in-service engines are equipped with an Engine Monitoring System (EMS) or other operating time recorders. For engines without EMS or other operating time recorders, oil analysis trending intervals will be standardized based upon Engine Flying Hours (EFH).

3.1. Analyze oil samples from transient aircraft IAW applicable technical data and owning activity requirements.

3.1.1. For transient aircraft with an EMS, at bases without the capability to download EOT data, EFH should be used to continue oil analysis trending.

3.2. Responsible activities must ensure the resultant data is accurate and given promptly to all customers so they can effectively monitor the condition of their equipment.

3.2.1. AF OAP laboratories will periodically (as specified by MAJCOM supplemental guidance) evaluate response times to optimize support of the customer.

3.3. Regional laboratories, servicing specific geographical areas, are the preferred mode of operation. Establish base laboratories only when equipment-directed response times or operational requirements rule out the use of a regional laboratory.

3.3.1. Each OAP laboratory must be certified annually IAW TOs 33-1-37-1/-2.

3.3.2. Seek to maximize inter-service use of existing laboratories through laboratory consolidation, workload sharing, and use of standardized instrumentation, techniques and procedures.

3.3.3. Non-depot AF OAP laboratories must provide oil analysis services at no charge for all US Government, NATO and friendly Foreign Military Service (FMS) aircraft. These services include analyzing oil samples from transient aircraft IAW applicable technical data within the AF OAP laboratory capabilities.

4. Roles and Responsibilities.

4.1. Headquarters Air Force. The Air Force Director of Logistics (AF/A4L) is the chief Air Staff agency with policy responsibility for the maintenance of air and space equipment.

4.1.1. Guidance. Prepares, publishes and reviews AF-level policy and guidance for the AF OAP. This publication should be reviewed every two years and revised, if necessary.

4.1.1.1. Coordinates with MAJCOMs to review and resolve guidance-related issues.

4.1.2. Management. Designates a point-of-contact (POC) for AF OAP. The representative shall manage this publication while closely coordinating with functional experts.

4.1.2.1. Maintains and distributes a list of POCs for AF OAP.

4.1.2.2. Works closely with AF representative to the JOAP-Coordinating Group (CG) on policy issues.

4.2. Major Command. Each MAJCOM establishes a headquarters POC for complying with MAJCOM OAP responsibilities.

4.2.1. Establishes or relocates OAP laboratories to support MAJCOM mission. Coordinates establishment or relocation with the AF OAP Manager.

4.2.2. Ensure quality deficiency reports are submitted to the unit Product Improvement Manager IAW TO 00-35D-54, *USAF Deficiency Reporting and Investigating System*. Deficiency reports must be submitted to engine program offices on all equipment requiring tear down or overhaul due to an OAP laboratory maintenance recommendation and on all oil-wetted component failures where no OAP laboratory maintenance recommendation was made.

4.2.3. Ensures laboratories provide the depot a computer-generated printout/record, for each engine undergoing scheduled maintenance or overhaul.

4.2.4. Ensures laboratories process and evaluate samples IAW TO 33-1-37-1/-2.

4.2.5. Ensures proper training of AF OAP laboratory technicians. This includes identifying training requirements to the Air Education and Training Command (AETC).

4.2.6. Ensures assigned shop instrumentation and equipment is not modified or used for non-OAP applications without AF OAP Office approval.

4.2.7. Provides guidance necessary to execute the AF OAP and ensures all subordinate organizations understand and properly execute AF OAP and JOAP responsibilities. Specific guidance may be provided in a MAJCOM supplement to this publication and/or AFI 21-101, *Aircraft and Equipment Maintenance Management*.

4.2.8. Ensures AF OAP and JOAP requirements are included in planning, programming and budgeting process. This includes providing needed funds, personnel, facilities and other resources to maintain an effective program.

4.2.9. Supports equipment evaluations and field surveys for the AF OAP Office.

4.3. Air Force Materiel Command. AFMC is the lead MAJCOM for the AF OAP and Air Force participation in the JOAP. AFMC is also responsible for oil analysis Research, Development, Test and Evaluation (RDT&E). HQ AFMC/A4 is the headquarters office of primary responsibility for AF OAP guidance coordination and implementation within AFMC.

4.3.1. Center Propulsion Divisions. The Center Propulsion Divisions are OC-ALC/GKG and ASC/WNW.

4.3.1.1. The Propulsion Division (OC-ALC/GKG) represents the Air Force on the JOAP-Executive Committee (EC).

4.3.1.1.1. Establishes, funds, staffs and directs the AF OAP Office.

4.3.1.2. The Development Program Manager (ASC/WNW) ensures oil analysis sampling provisions or other appropriate measures to detect oil-wetted failures are included during the design phase.

4.3.1.2.1. ASC/WE will provide the specification guidance for the oil analysis sampling provisions, where applicable, in the engine's design phase.

4.3.1.3. AF OAP Office (OC-ALC/GKGCD). The AF OAP Office manages the AF OAP, and in coordination with the MAJCOMs and propulsion community, leads AF participation in the JOAP.

4.3.1.3.1. Certifies/decertifies AF OAP laboratories for participation in the JOAP.

4.3.1.3.2. Maintains a list of AF OAP laboratories, equipment and customers.

4.3.1.3.3. Assists MAJCOM/Center managers in program execution. This includes recommending the establishment, location, and relocation of AF OAP laboratories.

4.3.1.3.3.1. Communicates AF OAP objectives, policies and procedures to

the Director of Propulsion, Engine OAP Managers, equipment specialists and program managers.

4.3.1.3.3.2. Evaluates the need for and performs special studies, as requested by the MAJCOMs or depots. In addition, the AF OAP Office should periodically conduct laboratory assistance/assessments to determine adequacy and effectiveness of the AF OAP. Identifies problems and recommends solutions.

4.3.1.3.4. Establishes and manages a data system, meeting tri-service requirements, to evaluate AF OAP participation and effectiveness and to provide engine program offices with historical data on oil sample analysis results.

4.3.1.3.5. Coordinates and consolidates AF/MAJCOM requirements with Army/Navy to ensure, where practical, the procurement of common OAP equipment.

4.3.1.3.6. Represents the Air Force on the JOAP-CG.

4.3.1.3.7. Staffs and funds the JOAP-Technical Support Center (TSC) based on its charter and the tri-service memorandum of agreement.

4.3.1.3.7.1. Develops a comprehensive OAP laboratory certification and quality control program.

4.3.1.3.8. Maintains and provides Air Force inputs to TOs 33-1-37-1/-2/-3/-4, JOAP Manual.

4.3.1.3.9. Reviews and evaluates the JOAP school curriculum.

4.3.1.3.10. Assists the Engine OAP Manager and serves as an advisor for the engine Maintenance Planning Working Group (MPWG) for OAP issues.

4.3.2. Director of Propulsion. The DOP (OC-ALC/GKP) in conjunction with Engine Single Managers at OC-ALC/GKG, ASC-WNW and the AF OAP Office assess existing/potential oil analysis technologies. The DOP also ensures wear metal debris and oil analysis is an integral part of the Engine Health Management Program. The DOP appoints Engine OAP Managers for each Air Force-managed engine.

4.3.2.1. Engine OAP Managers. The Engine OAP Manager is the engineer in charge of a particular engine and is solely responsible for the OAP-related issues on that particular engine. Provides guidance necessary to accomplish engine-specific oil analysis.

4.3.2.1.1. Serves as the focal point for the engine Maintenance Planning Working Group (MPWG) for OAP issues.

4.3.2.1.2. Ensures expeditious handling of equipment returned for tear down or overhaul because of an OAP laboratory maintenance recommendation or where oil analysis results indicated a potential problem.

4.3.2.1.3. Provides guidance necessary to accomplish engine-specific oil analysis. Provides updates for TOs 33-1-37-1/-2/-3/-4 to the OAP Office.

4.3.2.1.4. Provides accurate and timely feedback to the MPWG and field units on

OAP-monitored equipment. This includes maintenance findings on equipment in for tear down or overhaul as a result of an OAP laboratory maintenance recommendation. It also includes failure reports and related wear metal and oil analysis data on oil-wetted components where no OAP laboratory maintenance recommendation was made.

4.3.2.1.5. Works with the MPWG to establish and maintain wear metal limits, diagnostic criteria and other oil analysis parameters. This is based on a review of data from equipment tear-down and overhaul findings.

4.3.2.1.6. Maintains metrics on hits, misses and escapes. Once oil analysis data is included in the Engine Health Management AF Enterprise Center with software capability to perform metric monitoring, the AFOAP will concurrently monitor metrics with the Engine OAP managers.

4.3.2.1.7. Works with the MPWG, MAJCOM customers and the AF OAP Office to establish engine-specific technical and performance requirements for all wear metal debris and oil analysis equipment.

4.3.2.1.8. Utilizes the Component Improvement Program (CIP) as needed to evaluate the cost effectiveness of existing and potential wear metal debris and oil analysis applications, establish test programs and implement the most cost effective method(s).

4.3.2.1.9. Sends updates of specific oil sampling intervals and wear metal limits (evaluate for new engines during the design phase; reconsider for existing engines when oil-wetted parts undergo any material or strength changes) to the MPWG.

4.3.3. Directorate of Air and Space Equipment Maintenance (WR-ALC/GR). The Directorate of Air and Space Equipment Maintenance procures oil analysis equipment at the request of the AF OAP Office or the JOAP-TSC.

4.3.3.1. Maintains a contract for procurement of JOAP AE spectrometers used by the Army, Navy, Air Force and JOAP TSC laboratories.

4.3.3.2. Provides technical order provisioning and support.

4.3.3.3. Establishes inter-service logistics support. This includes spare parts support, instrument repair and overhaul, procurement of common JOAP laboratory equipment and supplies, item management and equipment specialist activities, and funding status of existing contracts.

4.3.4. Air Force Research Laboratory (AFRL). AFRL accomplishes RDT&E to improve wear metal and oil analysis instruments, materials and techniques.

4.3.4.1. Supports the JOAP-TSC charter to conduct test and evaluation for the oil analysis programs, including the JOAP and the AF OAP, as applicable.

4.3.4.2. Coordinates RDT&E activities with the MAJCOMs, DOP, AF OAP Office and the JOAP-TSC, as applicable.

4.4. AETC. Provides initial oil analysis training for AFSC 2A7X2 through the Nondestructive Inspection course. The AF OAP Management Office and MAJCOMs may request additional training, as required.

4.4.1. Coordinates course material changes with the AF OAP Office, the JOAP-TSC and the MAJCOM POCs.

5. Reporting and Measurement. All MAJCOMs and laboratories must collect and report metrics to the AF OAP Manager IAW TOs 33-1-37-1/-2/-3/-4. All laboratories must collect and report hits, misses and escapes as a minimum.

6. Adopted Forms:

AF Form 847, *Recommendation for Change of Publication*

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DCS/Logistics, Installations & Mission Support

Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

AFI 21-101, *Aircraft and Equipment Maintenance Management*, 26 Jul 2010
AFI 21-105, *Air and Space Equipment Structural Maintenance*, 9 Apr 2003
AFI 21-118, *Improving Aerospace Equipment Reliability and Maintainability*, 2 Oct 2003
AFI 21-131(I), *Joint Oil Analysis Program*, 28 Jul 2008
AFMAN 33-363, *Management of Records*, 1 Mar 2008
AFPD 21-1, *Air and Space Maintenance*, 25 Feb 2003
AFPD 63-1, *Acquisition and Sustainment Life Cycle Management*, 3 Apr 2009
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DoDD 4151.18, *Maintenance of Military Materiel*, 31 Mar 2004
DoDI 5025.12, *Standardization of Military and Associated Terminology*, 14 Aug 2009
JP 1-02, *DOD Dictionary of Military and Associated Terms*, 12 Apr 2001
TO 00-35D-54, *USAF Deficiency Reporting and Investigating System*, 1 Oct 2009
TOs 33-1-37-1/-2/-3/-4, *Joint Oil Analysis Program Laboratory Manual*, 12 Sept 2008

Abbreviations and Acronyms

AE—Atomic Emission
AETC—Air Education and Training Command
AF—Air Force
AFI—Air Force Instruction
AFI(I)—Air Force Instruction (Interservice)
AFMC—Air Force Materiel Command
AFMAN—Air Force Manual
AFPD—Air Force Policy Directive
AFRC—Air Force Reserve Command
AFRIMS—Air Force Records Information Management System
AFRL—Air Force Research Laboratory
ALC—Air Logistics Center
ANG—Air National Guard
ASC—Aeronautical Systems Center
CG—Coordinating Group

CIP—Component Improvement Program
DoD—Department of Defense
DoDD—Department of Defense Directive
EC—Executive Committee
EDX—Energy Dispersive X-ray
EFH—Engine Flying Hours
EMS—Engine Monitoring System
EOT—Engine Operating Time
FDA—Filter Debris Analysis
FMS—Foreign Military Sales
IAW—In Accordance With
JDMCB—Joint Data Management Control Board
JESC—Joint Equipment Standardization Committee
JOAP—Joint Oil Analysis Program
MAJCOM—Major Command
MCD—Magnetic Chip Detector
MIS—Maintenance Information System
MPWG—Maintenance Planning Working Group
OAP—Oil Analysis Program
OC—Oklahoma City
OPR—Office of Primary Responsibility
OSS&E—Operational Safety, Suitability & Effectiveness
POC—Point of Contact
DOP—Director of Propulsion
QA—Quality Assurance
R&M—Reliability & Maintainability
RCM—Reliability Centered Maintenance
RDS—Records Disposition Schedule
RDT&E—Research, Development, Test and Evaluation
SEM—Scanning Electron Microscope
TO—Technical Order
TSC—Technical Support Center

USAF—United States Air Force

WR—Warner-Robins

Terms

Air and Space Equipment—Equipment used and maintained to meet the Air Force mission. It includes aircraft, missiles, space equipment, communications-electronic equipment, avionics, engines, training equipment, support equipment, aircraft and space ground equipment, sound suppressor systems, test, measurement and diagnostic equipment and major end items of all equipment.

Certification—The process by which a laboratory and its personnel are determined to be capable and qualified to analyze oil samples, evaluate oil analysis results, and make maintenance recommendations based upon those analytical results.

Certification Program—A program managed by the JOAP–TSC in coordination with each service oil analysis program management office, to ensure that laboratories and personnel meet certification requirements of individual service oil analysis programs. A program to assure OAP laboratories are qualified to analyze fluid samples, evaluate the results, and make proper maintenance recommendations.

Common Instrumentation—Instruments used by two or more of the services to analyze used fluids.

Common Operating Equipment—Equipment that has common functions, oil-wetted parts of like design and similar failure modes.

Correlation Program—A program managed by the JOAP–TSC in which all JOAP laboratories receive and analyze standardized mineral and synthetic oil samples.

Correlation Sample—A sample of oil, synthetic or mineral, prepared by the JOAP–TSC and used to monitor instrument capability to produce desired results and laboratory personnel compliance with JOAP technical order procedures. Correlation sample data provide critical information relative to a laboratory's certification status.

Customer—Any activity authorized by the JOAP–CG to submit samples to and receive oil analysis results and recommendations from a JOAP laboratory. Any JOAP–CG member may authorize customers to use his or her service's laboratory if the additional workload does not interfere with an existing workload.

Escape—An in-service failure or abnormal wear finding where no OAP laboratory maintenance recommendation was made.

Evaluation Criteria—Information used by oil analysis laboratories in the evaluation of oil analysis results. Evaluation criteria may comprise wear-metal limits, wear-metal trends, decision tables, physical test limits, component part composition, component diagrams, and specific comments related to the particular component from which an oil sample is taken.

Hit—An OAP laboratory maintenance recommendation confirmed by a physical finding of abnormal wear or potential for catastrophic failure.

Inter—Service Customer—An activity within the services that has oil analysis support provided by another service's laboratory.

Inter—Service Maintenance Support—Maintenance either recurring or nonrecurring, performed by the organic capability of one Military Service, or element of it, in support of another Military Service or element.

JOAP Coordinating Group (JOAP—CG) —A working group responsible for implementing and

monitoring JOAP activities. It is composed of oil analysis program management representatives from the Army, Navy, and Air Force. The Marine Corps and Coast Guard may be included as nonvoting, associate members of the JOAP—CG.

JOAP Executive Committee (JOAP EC)—A team of O6-level representatives from the JOAP offices of prime responsibility for the services, which works under the authority and direction of the Air Force Materiel Command, the Army Materiel Command, and the Naval Air Systems Command. The JOAP EC provides oversight to JOAP Coordinating Group activities.

JOAP Laboratory—An Army Navy, or Air Force oil analysis laboratory operating according to OAP regulations. Its personnel must be certified according to established JOAP procedures and capable of providing oil analysis support to the other services.

JOAP Manual—A tri-service manual (NAVAIP 17–15–50.1/50.2/50.3/50.4, TM 38–301–1/–2/–3/–4, and TO 33–1–37–1/–2/–3/–4) containing consolidated procedures, methods, and evaluation criteria used by JOAP oil analysis laboratories and customers.

JOAP Office of Primary Responsibility (OPR)—The Army, Navy, and Air Force executive agents responsible for ensuring effective inter-service policy coordination and problem resolution and providing management control over the irrespective service oil analysis programs.

JOAP Spectrometer—An analytical instrument, approved by the JOAP-CG, used to detect and measure designated wear metals contained in lubricating oils and other fluid samples.

JOAP Technical Support Center (JOAP—TSC) —An organization composed of technical representatives from each service that provides technical support to the JOAP and performs technical task for the JOAP—CG.

Joint Data Management Control Board (JDMCB)—A working group tasked to ensure standardization of computer codes, review individual service data requirements, and provide for effective data system integration across Service lines.

Joint Equipment Standardization Committee (JESC)—A working group tasked to serve as the integrating focal point among the three services for consolidating functional requirements for standard JOAP equipment. The JESC will also coordinate evaluation criteria and test and evaluation plans in support of joint evaluation and testing projects accomplished by the JOAP—TSC.

Maintenance Planning Working Group (MPWG)—The MPWG is a team consisting of the engine managers from each using MAJCOM, representatives from the using community, government development and depot teams, and the engine manufacturer. The purpose of the MPWG is to review and direct the life management and maintenance plans for the engine. The

MPWG determines the objectives and content of their maintenance program. MPWG plans are updated based on field and depot experience.

Miss—An OAP laboratory maintenance recommendation followed by a physical finding of no abnormal wear or potential for catastrophic failure.

Oil Analysis—The process of analyzing oil and other fluids used to lubricate or operate mechanical equipment, evaluating the condition of the fluid or the equipment from which the fluid originated, and recommending maintenance actions to the equipment operating activity.

Oil—Wetted Air—Oil moistened air used for lubrication and decreases friction between parts.

Physical Property Analysis—Analytical procedures used to determine the suitability of a lubricant or fluid for continued use. Tests include analyses for water and fuel contamination, fluid viscosity, and solids contamination.

Reliability—Centered Maintenance—A logical discipline for developing a scheduled-maintenance program that will realize the inherent reliability levels of complex equipment at minimum cost.

Response Time—The elapsed work hours from the time that an analysis request is received in the oil analysis laboratory and required processing is completed. Laboratory processing is completed when the sample analysis is evaluated and, if required, action is taken to notify the customer of a maintenance recommendation.

Spectrometer—An instrument which uses the atomic emission or atomic absorption principle to identify the types and concentrations of wear metals in used fluid samples.

Spectrometric Analysis—A technique used to detect and measure wear metals and other elements from oil-wetted components in aeronautical and non-aeronautical equipment components and to alert maintenance personnel about conditions that may lead to component failure if not corrected.

Spectrometric Calibration Standard—A mineral oil that contains known quantities of specific organometallic compounds, has a controlled viscosity and flash point, and is used to calibrate and standardize spectrometers. Standards composition must be approved by the JOAP–CG.

Technical Order—An AF publication that gives specific technical directives and information on inspection, storage, operation, modification, and maintenance of given AF items and equipment.

Turn—around Time—The interval encompassing the period from the time the samples is taken until an answer (maintenance recommendation, request for resample, etc.) is received by the customer. Turn-around requirements may vary for the individual customers.

Transient Aircraft—Aircraft not assigned to a base that are en route from one location to another that may require routine servicing. Aircraft deploying to or staging from a base for the purpose of flying sorties or conducting training with a squadron assigned to the base, with or without the necessary maintenance support from the home base, are not considered transient aircraft.

Viscosity Calibration Standard—A fluid of known viscosity used by oil analysis laboratories to standardize the viscometer.